"OPERATION HAZEN"

PHASE III MAY - AUGUST 1958

PRELIMINARY REPORT ON THE METEOROLOGY AND MICROMETEOROLOGY, GILMAN GLACIER CAMP.

James R. Lotz

Meteorologist - McGill University

November 1958

METEOROLOGY AND MICROMETEOROLOGY

GILMAN GLACIER CAMP

James R. Lotz

SUMMARY OF OBSERVATIONS.

The meteorological and micrometeorological programme on the Gilman Glacier during the summer of 1958 was an extension of that begun during the previous summer. Observations began at an earlier date in 1958, and ended later. During 1958, radiation studies were carried out, using an actinograph and a net radiometer.

The camp on the Gilman Glacier where the meteorological equipment was set up in 1958 was located several hundred yards up-glacier from the 1957 site, at an altitude of 3407' above sea level. For all practical purposes, the two locations can be considered to be identical.

Meteorological observations began at 0800 on May 5th, and were carried out three times a day at 0800, 1400, and 2000. Observations at the six hour intervals consisted of screen temperature by standard thermometer, six-hourly maximum and minimum temperatures, wind speed at four feet above the glacier surface by hand anemometer, wind direction by flag on the mast, horizontal vibility, precipitation, cloud types and amount. A continuous thermograph record was kept, beginning on May 5th, and readings were taken from it at the six-hourly intervals. A daily sunshine record was kept from May 5th also. On May 12th, at 0800, a continuous hygrograph record began, and relative humidity in the screen was measured by a wet and dry bulb psychrometer from 2000 hours on May 15th. A continuous barograph record began at 1830 on May 15th, and the aneroid barometer was read every six hours during the day, beginning at 2000 on the same day. Snow temperatures at the surface were read every two hours from 0800 on May 15th to 2200 on July 4th, when the last of the snow disappeared.

The micrometeorological work started at 0800 on May 19th, and continued through to 2000 on August 12th. In addition to the six-hourly synoptic observations, the screen temperature, relative humidity, wind direction, visibility, and cloud type and cover were recorded every two hours from 0800 to 2200 daily. On the mast

..../2

wind speeds at four levels above the glacier surface - 10 centimetres, 1 metre, 3 metres, and 10 metres - were recorded at two-hourly intervals, as were air temperatures.

In all, synoptic observations were carried out for a period of 100 days; micrometeorological records cover 86 days.

Radiation studies began on May 5th, when the first readings were taken with the net radiometer. Unfortunately this radiometer must be covered up, and cannot be read when precipitation is falling. It became the practise to read the instrument at the two-hourly observations during the day, when it was not snowing or raining, and to obtain other readings at different times during the day and night. In all 741 readings of net radiation flux were taken over a period of 99 days. Only on June 4th was the weather so bad that no values of net radiation flux could be obtained. The Casella bimetallic actinograph, for measuring short wave solar radiation, suffered sporadically from clock trouble during the summer, with the result that the record for this only extends over a 65 day period. The actinograph was put into operation at 1100 on May 18th, and stopped at 1200 on August 12th. From June 9th, after a running-in period, the actinograph ran from 1020 on one day to 1020 on the following day, and from July 9th, after a break in the record, the run was from 1200 on one day to 1200 on the following day.

Three ablation stakes were set around the base of the meteorological mast, and read every day at 2000 from May 27th to August 15th. Six other ablation stakes , AS1-AS6, set approximately half a mile down glacier were read every Wednesday from June 25th to July 30th, then twice a week after this until August 15th.

THE SUMMER OF 1958 IN NORTHERN ELLESMERE ISLAND COMPARED TO THE LONG TERM RECORD

Data from the only two weather stations in Northern Ellesmere Island, Eureka and Alert, tend to confuse rather than to clarify any attempt to compare the summer of 1958 with other summers or with the long term means. For June and July 1957, both stations had higher mean daily temperatures, higher mean daily maxima, and higher

...5/

mean daily minima than the long term means. At both stations, precipitation, both during the 1956-57 budget year, and during the summer, was well below the long term mean for both stations. Therefore, despite differences in location between the two stations, and the influence of local factors, it is very probable, for Northern Ellesmere as a whole, that the summer of 1957 was warmer and drier than usual.

During the summer of 1958, there were considerable differences in the temperature and precipitation readings at the two stations as compared to the long term means. There were also differences in temperature and precipitation trends for the two stations. At Eureka, for instance, mean daily temperatures during 1958 were slightly higher than the 1947-58 mean for May, lower during June, and approximately the same during July. At Alert, the mean daily temperature for May 1958 was 4.1°F. higher than the monthly mean for the period 1950-58, but mean daily temperatures during June and July were approximately the same as the means for the long term period. For the budget year at Eureka, August through to May, there was more precipitation (2.89") during 1957-58 than the mean for the same period during 1948-58 (1.90"). For Alert, the corresponding figures for the budget year are 2.89" and 4.55".

On the basis of these figures for Alert and Eureka, it is impossible to generalize about the summer in Northern Ellesmere Island in 1958 as compared to the long term means for the area.

TEMPERATURE

The summer of 1957 was warmer than the summer of 1958 on the Gilman Glacier. The mean daily temperature in the screen for June 1957 was 28.8°F., the mean maximum was 34.3°F., and the mean minimum was 25.4°F. For June 1958, the corresponding figures were 27.7°F., 32.4°F., and 23.1°F. In July, the mean daily temperature in the screen was 36.1°F. in 1957, 33.8°F. in 1958. The maximum temperature recorded in 1957 was 46.4°F. on June 25th; in 1958, the maximum was 44.4°F. at 1800 on July 6th. The warmest day in 1958 was July 6th with a mean daily temperature of 39.0°F. The lowest temperature recorded in 1958 was -8.9°F. at 0000 on May 7th; in 1957 min temp recorded was +3.4°F at 0300 on May 25th.

As in 1957, the thermograph traces during the summer of 1958 showed a marked

diurnal variation, and many sudden rises and falls in temperature before the melt got firmly under way, and a much straighter characteristic after June 23rd. Even during the period July 25th - 28th, when there was no ablation, temperatures in the screen remained steady and showed little variation.* → to Bram

The onset of the melt was very sudden, and this feature was noted during 1957 also. The mean daily temperature on June 7th was 17.0°F., on June 8th it went up to 26.0°F., On June 6th, the daily maximum was 15.2°F., on June 7th it was 24.8°F., and on June 8th, the high recorded was 36.0°F.

The temperatures on the mast showed the same sudden upsurge in early June. On June 6th., the mean temperature for the four levels on the mast between 0800 and 2200 was 18.2°F; on June 7th. it was 33.3°F. At the 10 cm. and the 1 m. level, the mean daytime temperature went above freezing on June 8th, and never fell below 32.0°F. during the period of observations except on two occasions. In 1957, this sudden upsurge of temperature occurred on June 12th.

An analysis of the temperature profile on the mast showed that during the period May 19th to August 12th, 27.0% of the observations showed a straight increase of temperature from 10 cms. to 10 m. In all, increases in temperature from 10 cms. to 10m, directly or indirectly, were noted during 75.1% of the observations.

As in 1957, it was found that the control that the glacier has over the actual temperatures above its surface is not very strong. For the period May 19th to August 12th, the temperature at 10 cms. dropped below freezing during 29.1%, 27.9% and 27.0% of the time respectively. Practically all the temperatures below freezing at all levels on the mast were recorded during the days before June 8th.

RELATIVE HUMIDITY

During the summer of 1957, the general level of relative humidity was around 80%. Means for June, July and early August for that year were 81%, 84% and 88%. During 1958, although the air above the glacier was very seldom saturated, and then only during

....5/

.../6

occasional days, the mean relative humidities for June and July were 79% and 82%. In August, the relative humidity for the first twelve days was 75%, but the weather during the early part of this month in 1957 was in very marked contrast to that prevailing during early August 1958. There were marked changes in relative humidity during the day from hour to hour, and variations of 20% within a matter of minutes were noted right through the summer.

The only marked correlation between relative humidity and wind direction was between high humidity and a south-east wind. An up-glacier wind usually meant an incursion of more humid air, and this was reflected in the figure 93% relative humidity with a south-east wind, compared to a mean of 78% for observations when a north-west wind was blowing. The dominance of north-west winds, however, tends to give an unbalanced picture of such a correlation.

WIND.

As during the summer of 1957, the dominant features of wind observations were the prevalence of north-west (down-glacier) winds, the large percentage of calms, and the generally light nature of the winds at all levels. In May, 57% of all winds were from the north-west, and for June, July and August the percentages were 50.1, 41.2, and 72.9. During August, when a high dominated the area, all winds recorded during the first twelve days were either from the north-west or from the north. For the whole period of observations, winds from the north-west accounted for 51.4% of all observations, north winds occurred 12.6% of the time, and calms were recorded at 18.7% of the observations. Calms accounted for 32.0% of all observations in May, 17.9% in June, and 18.5% in July 1958.

Winds at all levels on the mast tended to be light, and seldom exceeded ten miles per hour. At the 10 cm. level only 3.1% of all winds were over 10 m.p.h., and the 1 m., 3m., and 10 m. levels had winds over this speed during 8.2%, 15.4% and 24.0% of all observations. The highest wind speed recorded on the mast was 36.0 m.p.h. at 10 m., on July 7th, and only the 10 m. level recorded winds over 30 m.p.h.

Wind speed gradients showed a straight increase with height 36.5% of the time, and, in all, an increase from 10 cm. to 1 m with or without intermediate decreases 61.1% of the time. Increases to 3 m., then a drop in speed to 10 m. was recorded during 15.6% of the observations - the only significant example of decreases in wind speed with increasing height.

PRESSURE

During the summer of 1958, the pressure pattern was similar to that of the summer of 1957 - little sudden change, with the barograph trace almost a straight line at times. The highest mean daily pressure recorded was 908.8 mbs. on June 8th, the lowest 887.4 mbs. on May 28th.

CLOUDS AND CLOUDINESS

The mean monthly cloudiness for May, June, July and early August 1958 was 4.7/10, 5.9/10, 7.4/10, and 3.3/10. There were more completely overcast days during 1958, five days having 10/10 cover for the period 0800 to 2200 compared to only two during 1957. Again there was a marked difference between the pre-melt period before mid-June, and the cloud conditions during the melt season, this being reflected in the mean daily cloudiness for June as compared to that for July. In contrast to 1957, the first few days of August 1958 had a low mean daily cloudiness when a high pressure system covered the area.

The frequency of different cloud types was as follows.

Cloud Form	Fog	St-Forms	Cu-Forms	A-Forms	Ci-Forms
% Frequency	10.3	43.5	5.1	27.5	13.6

Again the relatively low percentage of fog and st-forms compared to the records on other glaciers and Icecaps is noteworthy. In 1957 Fog and st-forms were recorded during 35.7% of the observations. Stratocumulus formed the largest percentage of any single cloud type in 1958, occurring during 28.3% of the time.

FOG AND VISIBILITY

Fog as an obstruction to visibility was noted at 68 of the 730 observations during the summer of 1958. There was little fog during May, and none in August. From 1800 on June 20th to 0800 on June 25th, heavy fog persisted at the camp in association with

snow and drizzle, and from July 23rd to July 29th fog, again associated with light snow, cut down visibility at the camp at most of the observations. For the whole summer of 1958, only 67 observations had visibilities of one mile or less. During every month in 1958 the visibility was 30 miles or over for more than 50% of the observations. The visibility during the first twelve days of August was 30 miles or over on 93 out of 96 observations.

Drifting snow was noted on five occasions, and blowing snow on nineteen occasions. This is in marked contrast to 1957 when there was only one observation of blowing snow. In 1958, snow was blown down from the head of the glacier over the camp on July 7th - 8th.

SUNSHINE

A high sunshine record was characteristic of the summer of 1958 as well as of the the summer of 1957. For the period May 5th - August 12th, the total number of hours of sunshine was 1420.5 out of a possible 2400, an average of 14.2 hours daily, and a percentage of 59.2. During the period May5th - May 22nd, there were nine days with continuous sunshine, and the first fourteen days of June had eight with twenty four hours of sunshine. The first twelve days of August 1958 had an average of 18.8 hours of daily sunshine, compared to 5.8 hours for the first eight days of August 1957. June and July had fewer hours of sunshine in 1958 as compared to 1957.

PRECIPITATION

There was hoar frost accumulation at the station on May 21st, May 31 st and June 2nd. On May 31st, 0.8 to 1.0 cms. of hoar frost accumulated on wires, bamboo poles and the mast, and on June 21st 1.5 to 1.9 cms. of rime ice formed. There was a fall of ice crystals on May 21st, and a hail shower on June 28th.

Snow first fell on May 5th, the day observations began. Total snowfall for the period May 5 th - 31st, 1958 was 2.4". June 1958 had a markedly higher precipitation with 6.2" of snow and .08" of rain compared to the 1.4" of snow and the .01" of rain that fell during the same month in 1957. July and August 1958 had lower precipitation totals than the corresponding months in 1957. July 1958 had 2.5" of snow and .23" of rain; the same month in 1957 had 3.8" of snow and .27" of rain. Only a trace of snow was recorded during August 1958, when the glacier was under the influence of a

large high pressure system. In August 1957, when the area was under the influence of a large semi-permanent low north of the Bering Strait, 2.4" of snow and .09" of rain fell during the first eight days of the month.

A comparison of the precipitation during the two summers is as follows.

	Rain	Snow	Total	Days with measurable rain,	snow
1958					
May 5th - August 12th	.31	11.1	1.42	8	20
1957					
May 18th - August 8th	.37	9.5	1.32	5	10

ABLATION

The ice ablation at the camp and down the glacier at stakes AS1-AS6 is summarized as follows.

Total ablation to August 15th in cms.

No 1	No 2	No 3	Mean
44.4	38.0	47.8	43.4

AS1	AS2	AS3	AS4	AS5	AS6	Mean
72,5	58.0	74.0	65.0	54.0	81.5	67.5

The mean ablation of ice at the stakes around the mast in 1957, 79.9 cms., was almost twice as much as in 1958.

The ablation season began quite suddenly on June 10th, when snow began to melt at the poles around the mast. It proceeded sporadically, with some accumulation at the poles until June 24th, when it really got under way. All the snow had disappeared from the three poles by June 29th, and ice ablation continued after this until July 24th. From July 25th to July 28th, there was no ice ablation at any of the poles. Ablation continued at a slower rate from July 29th to August 15th, with no melting at any of the poles on August 7th and August 12th. Ablation was still going on when the camp was abandoned on August 16th, but all indications were that the melt season was almost at an end. The period of maximum ice ablation occurred in early July, and the maximum mean daily ablation at the base of the mast was 3.4 cms. on July 6th.

The correspondence of various meteorological factors with ablation, as in 1957, showed that the amount of ablation was directly related to daily maximum temperatures

RADIATION

NET RADIATION

In the early part of the season, practically every observation of net radiation showed more outgoing radiation than incoming. With clear skies and a snow cover, values of net radiation flux reached a maximum of -.25225 langleys per minute at 1235 on May 6th. Incoming net radiation seldom exceeded outgoing radiation until mid-June. Beginning on June 20th net radiation began to show positive values at practically every observation. In mid-June, however, especially late in the evening, there were large values of negative net radiation flux. On June 14th, with a sky cover of 1/10Cu,1/10 Ac and a snow cover, the radiation was -.1655 langleys per minute at 1800, and -.206625 langleys per minute at 2000. High values of incoming net radiation flux were obtained very early in the melt season. On June 20th, at 0800, with a sky cover of 5/10Sc, 2/10 Ac, the incoming radiation flux was +.215875 langleys per minute; at 1200, with 5/10 Sc, 3/10Ac it was +.26275 langleys per minute, and at 1400, with 2/10Sc, 5/10Ac it was +.24575 langleys per minute. The maximum incoming net radiation flux recorded was at 1400 on July 23rd, when, with a sky cover of 3/10F and 7/10Sc,the radiometer reading was +.282 langleys per minute. Towards the end of the summer, negative values of net radiation were increasingly obtained. Even on August 6th, however, at 1000 and at 1200 with a sky cover of 1/10Sc and 1/10Ci, the radiometer readings were +.265875 and +.232875 langleys per minute.

SHORT WAVE RADIATION.

The figures for short wave radiation have yet to be fully worked out. Maximum short wave radiation occurred at the beginning of the melt season between June 9th and June 15th.

CONCLUSION

This report has been a summary of the meteorological and micrometeorological work carried out during the summer of 1958, and some comparison has been made with the results obtained last summer. Now that two summers work has been completed, and extra radiation and glaciological data has been gathered, it will be possible to investigate the budget of the Gilman Glacier, and to study the problems of accumulation and ablation in this area.